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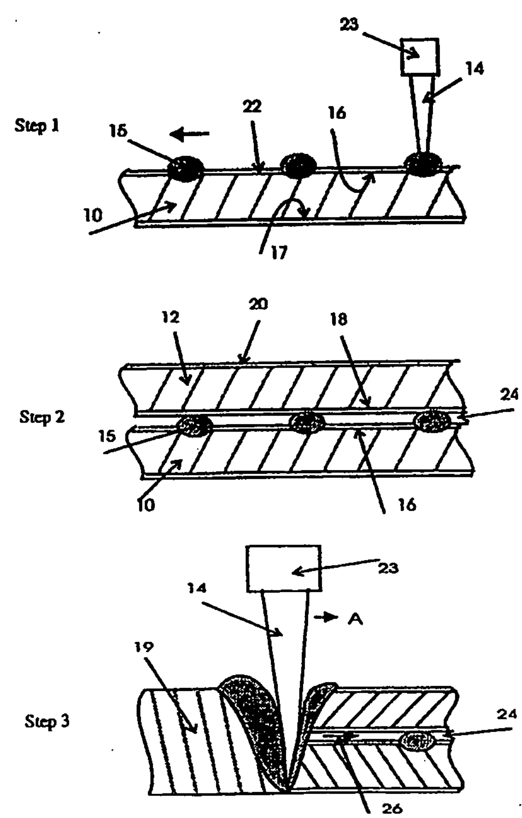
(54) Title: METHOD OF LASER BEAM WELDING OF ZINC–COATED STEEL SHEET

(57) Abstract

A pair of coated components are laser welded to one another by initially forming protuberances on one of the components. The protuberances maintain juxtaposed surfaces separated and the components are then laser welded to one another. The separation of the surfaces vents vapor generated by the coating.



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METHOD OF LASER BEAM WELDING OF ZINC-COATED STEEL SHEET

The present invention relates to a method of making lap joint of zinc coated steel sheets with a laser beam.

BACKGROUND OF THE INVENTION

The increased use of zinc-rich coated steel sheets in auto-body components for enhanced corrosion resistance poses a demand for an acceptable welding method to join these kinds of sheets. Laser beam welding has an advantage of low total heat input and thus causes a low distortion to the zinc-rich coating on the sheet. Therefore laser beam welding is being evaluated as a desirable joining technique for such sheet steel in butt and lap joint configurations. However, a problem arises with welding these materials in the lap-joint configuration due to the low boiling point of zinc (906°C) compared with the melting temperature of steel (~1550°C).

If there is no joint clearance between the sheets the zinc vapor during welding can only escape through the molten welding pool, and this typically results in excessive weld porosity or complete expulsion of the weld metal. In order to make a good quality weld, there are, in principle, two solutions to get around this problem: (1) creating a zinc-vapor venting channel during welding; or (2) removing the zinc coating in the welding pass. Both of these approaches need additional techniques to be realized. Many techniques have been developed to provide a gap between sheets to perform laser welding and to remove the zinc coat at the welding spot. These approaches typically require the use of supplementary components or spacers and cannot be employed in the production line, since additional equipment is required to create a gap or remove the coating. This will incur a significant expense and increase production time.

It is therefore an object of the present invention to obviate or mitigate the above disadvantages.

SUMMARY OF THE INVENTION

The present invention is intended to provide a practical and flexible way of making laser beam lap weld of zinc coated steel sheets. In general terms, a laser beam interaction with one surface of the material is used to create an acceptable gap between the sheets before the welding pass is performed.

More specifically, protuberances are formed on one surface of one sheet by impingement of a laser beam which maintains opposed surfaces of the sheets in spaced relationship. In this manner, the welding may be completed entirely on a single welding apparatus in an efficient cost-effective manner. With such a technique, it is possible to make a curved welding pass and it is applicable to 3D welding configuration. Therefore, this technique makes the production of laser beam lap welds of the zinc coated steel sheets possible using an existing butt welding system.

The preferred embodiment of the invention relates to a method of creating a gap for vapor gas venting by the laser beam before welding is performed. The principle is that a laser beam pulse with an appropriate pulse length can melt a spot on the metal sheet when it interacts with the metal and solidification of the molten metal forms a protuberance. The protuberance height above the sheet surface may be a few tenths millimeters. A series of protuberances in a line or curve serves as a spacer. When the laser pulse pre-processed sheet is put together with another sheet, a gap is formed. Laser welding can thus be performed along the spotted line/curve and go over the protuberances. The appropriate distance between two laser created protuberances depends upon the clamping force, laser beam power, scanning speed and the thickness of the metal sheets. In lap welding, the sheet on which laser pulses

generate protuberances can be either the top one or the bottom one. For both configurations, good quality welds can be produced.

DESCRIPTION OF THE INVENTION

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, in which

Figure 1 is a plan view of a pair of lap welded components;

Figure 2 is a view on the line 2-2 of the sequential steps in performing a weld on the components;

Figure 3 is an alternative embodiment showing the production of a spot weld;

Figure 4 is a photographic representation of a portion of one of the sheets shown in Figure 2;

Figure 5a is a photographic representation of a section on the weld shown in Figure 1;

Figure 5b is a photographic representation of a plan view of the weld shown in Figure 1; and

Figure 6 is photographic representations of welded components produced by the technique shown in Figure 2.

Referring therefore to Figure 1, a pair of components 10, 12 are connected by seam welding along a seam line 13 indicated in chain dot line. Each of the components is a steel sheet having oppositely directed surfaces 16, 17 and 18, 20 respectively. Each of the surfaces has a rust inhibiting coating, typically a zinc coating 22 to provide protection from corrosion.

As shown in Figure 2, one of the components to be welded, namely zinc-coated steel sheet 10 is placed on a welding table (any kind of table used for laser welding). A series of laser beam pulses 14 transmitted through laser head 23 are used to impinge on one of the surfaces 16 of the sheet 10 to create a series of protuberances 15 along the intended weld line 13. This process can be done by moving laser beam 14 over the sheet 10 or by manipulating the focusing optics of the laser head.

Once the pulsed protuberances are formed, the zinc-coated steel sheet 12 is placed on top of the laser-pulsed sheet 10 so that surface 18 overlies the surface 16. Alternatively, of course, the laser-pulsed steel sheet 10 may be placed on top of the other zinc-coated steel sheet 12. Under either condition, the steel sheets 10, 12 are pressed together by a clamp (not shown). As a result, two sheets to be welded are held together and are ready to be welded.

The protuberances 15 form an air gap 24 between the opposed surfaces 16, 18 of overlapping portions of the zinc-coated steel sheets 10, 12 along the weld line 13.

The welding operation is carried out by applying laser beam 14 to the steel sheets 10, 12 as indicated in Figure 2 by arrow A. During the welding, the zinc vapor 26 of the zinc-coating 22 can flow into the air gap 24 surrounding the welding keyhole. Therefore, no air holes or very few air holes are formed in the solidified metal weld 19. Thus, the resultant weld is satisfactory in quality.

In a typical welding operation using a 1.5 kW CO_2 laser, the protuberances 15 were formed by beam pulses of 100 - 150 millisec in duration. The thickness of the sheet 10 was ~1.0 mm and the material galvanneal steel. The height of the protuberances 15 was in the order of 0.4 mm with a diameter of in the order of 2 mm. As can be seen from Figure 4, the protuberance is irregular but of sufficient height to maintain the surfaces 16, 18 separated. The spacing of the protuberances was about 50 mm for the material selected although this spacing may vary according to the material.

The components 10, 12 were seam welded using the 1.5 kW laser in continuous mode traveling at a welding speed of 1.5 in/sec. The resultant weld is shown in Figure 5 where it can be seen that good homogeneity has been obtained.

The above embodiment has been described with respect to seam welding but a similar technique may be used for spot welding.

As shown in Figure 3, one of the components 10 to be welded is placed on a working table or frame. At the locations where laser spot welds are to be made, a laser beam pulse 14 impinges on surface 16 to create a protuberance 15. After all the locations are pulsed by laser beam 14, zinc-coated steel sheet 12 is placed on top and clamped. As a result of this configuration, an air gap is formed between two zinc-coated steel sheets around the laser-generated humps. The welding operation is carried out by applying a laser beam 14 to the steel sheets adjacent to each protuberance 15. The laser beam draws a circle of small radius around the protuberance to provide a localized circular weld. Welding will not affected if the path of the beam intercepts the protuberance.

As described in the seam welding embodiment above, the zinc vapor 26 escapes into the air gap around the hump. Therefore, a circular weld 19 is made and the resultant weld is satisfactory in quality. This circular weld can be considered as a spot weld.

It will be seen from the above description that the creation of natural spacer by this technique is simple and flexible as the laser beam can be put on anywhere on the sheet to create protuberances and to perform welding. Moreover, implementation of lap welding can be done with present laser welding systems with little additional costs.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of laser welding a pair of juxtaposed components comprising the steps of forming on one surface of one component a protuberance to project above said surface, juxtaposing said components such that opposed surfaces are maintained separated by said protuberance, and laser welding said components by impingement of a laser beam in the region in which said surfaces are separated.

2. A method according to claim 1 wherein said protuberance is formed by impingement by laser beam.

3. A method according to claim 1 wherein said weld is formed by rotating said beam about one of said protuberance.

4. A method according to any preceding claim 1 in which a plurality to protuberances are formed in spaced relationship along a surface of said one component.

5. A method according to claim 4 wherein said components are welded to one another by translating said laser beam along said surface in the direction of said protuberances.

6. A method according to claim 4 wherein said components are welded to one another by rotation of said beam about respective ones of said protuberances to provide a generally circular weld.

7. A method according to any preceding claim wherein at least one of said components is coated with a rust inhibiting coating.

8. A method according to claim 7 wherein said coating includes zinc.

9. A method of welding a pair of sheet metal components having a corrosive resistant coating to one another comprising the steps of impinging a laser beam upon one surface of one of the components to form a plurality of localized protuberances thereon at spaced intervals, juxtaposing said sheets with said protuberances interposed between said sheets to maintain a separation thereof, and welding said sheets to one another by impingement of said beam in the vicinity of said protuberances.

10. A method according to claim 9 wherein said welding is performed by translating said beam across said components.

11. A method according to claim 10 wherein said beam is rotated about said protuberances to provide a circular weld.

12. A method according to claim 9 wherein said beam intersects said protuberances during welding.

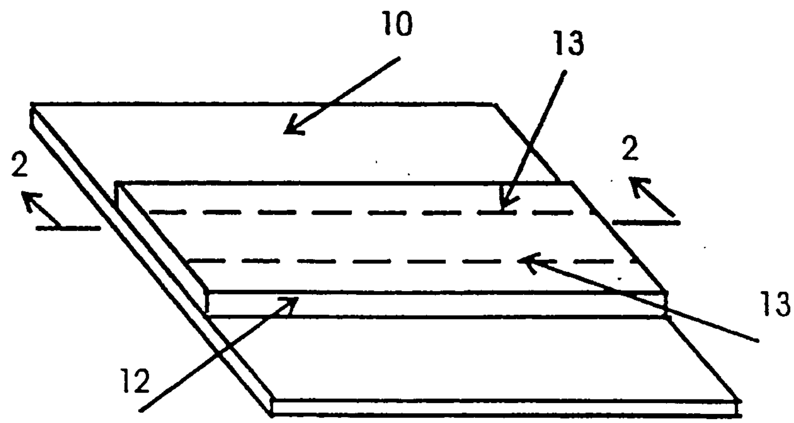
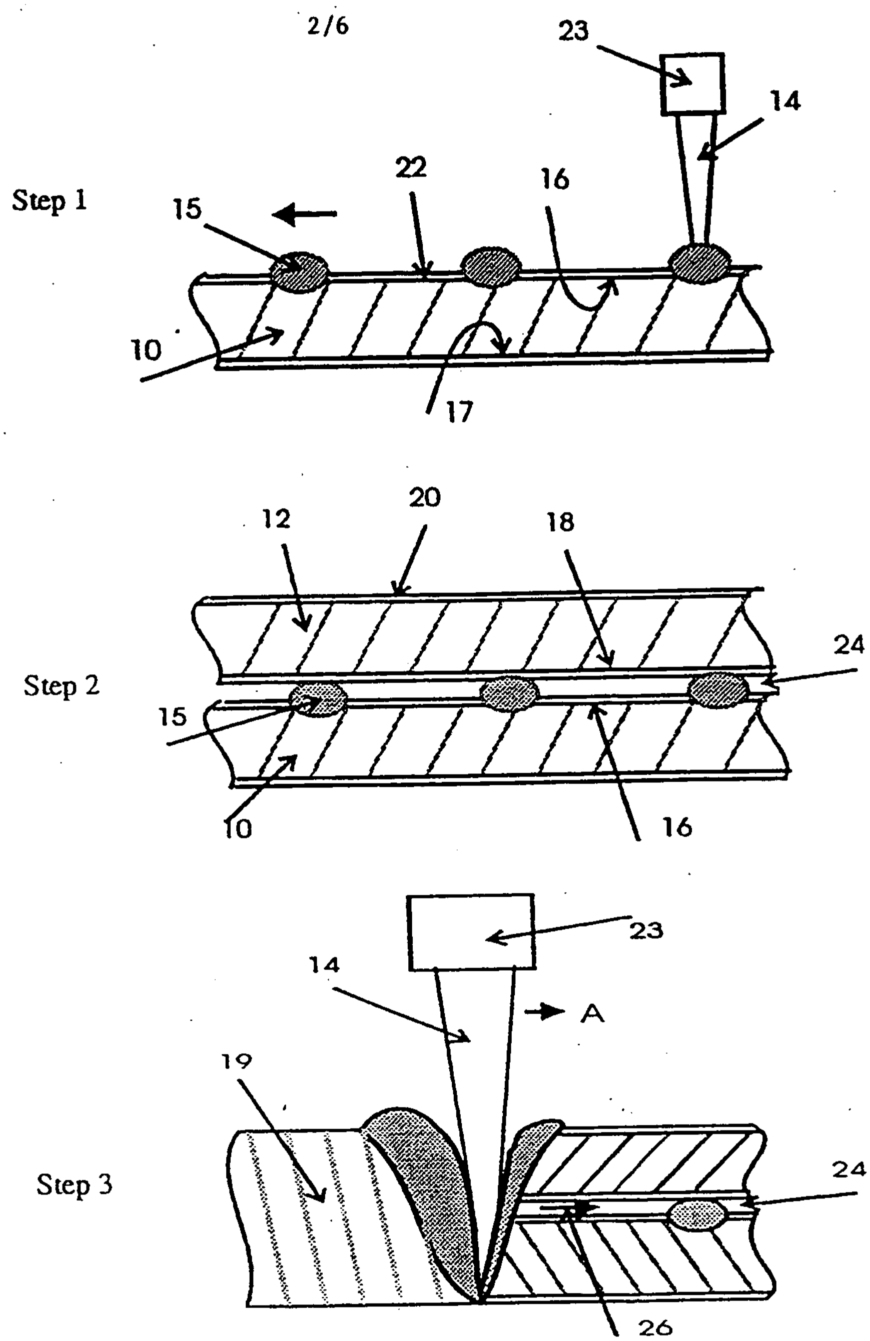


Fig. 1



23
14
22
16
Step 1
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18
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Step 2
15
10
16
23
14
A
19
Step 3
24
26

Fig. 2

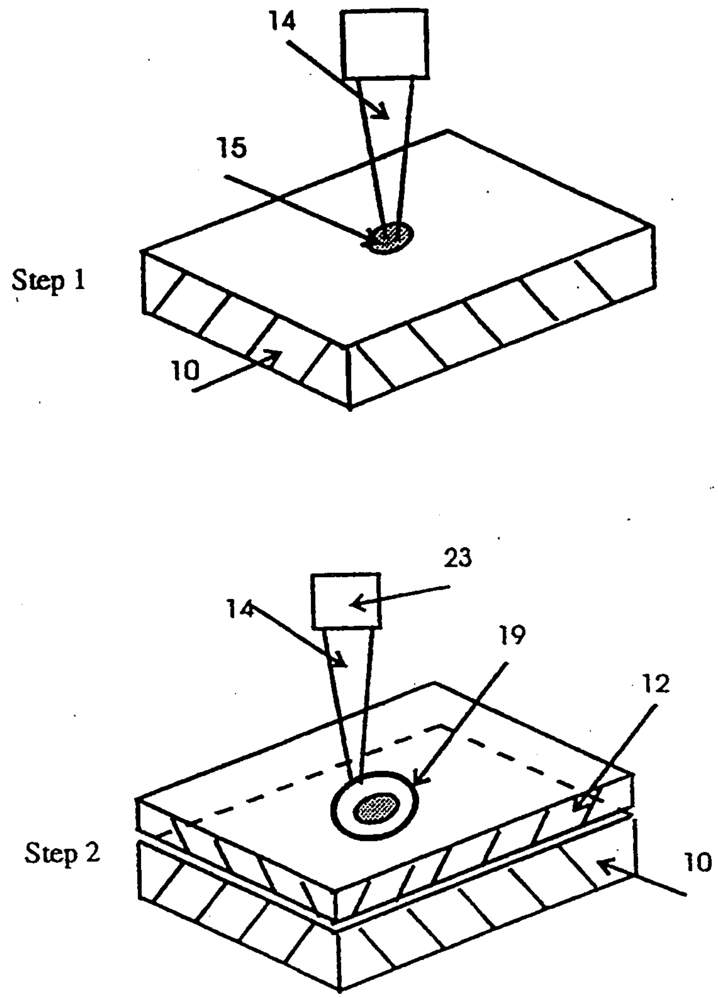


Fig. 3

Figure 4

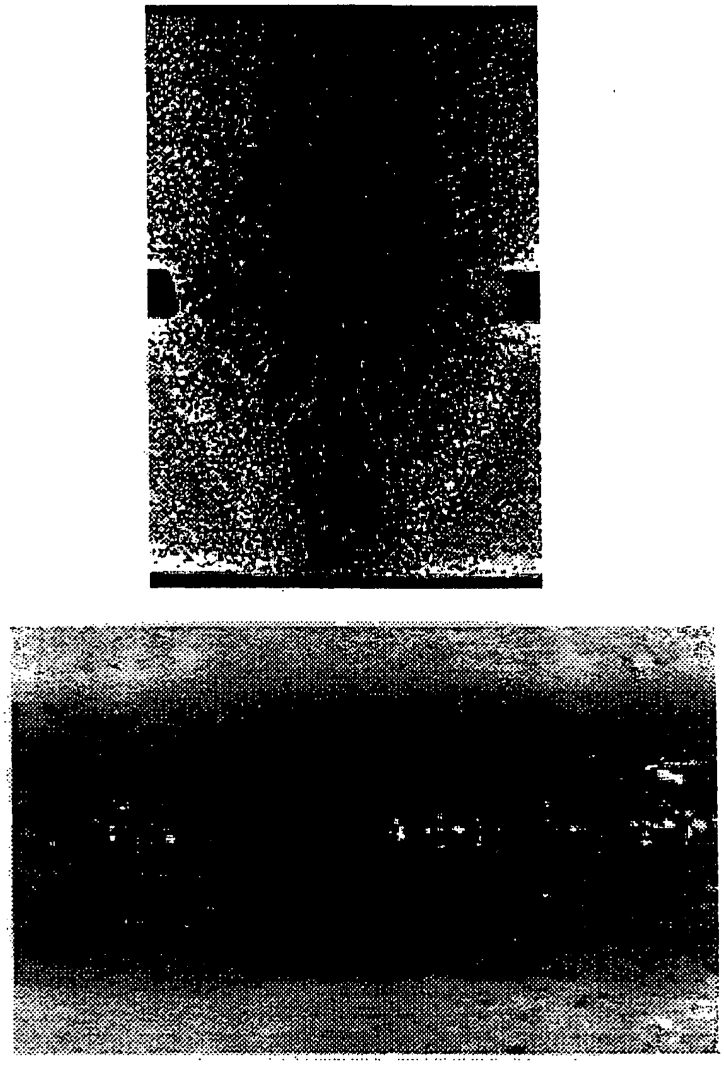
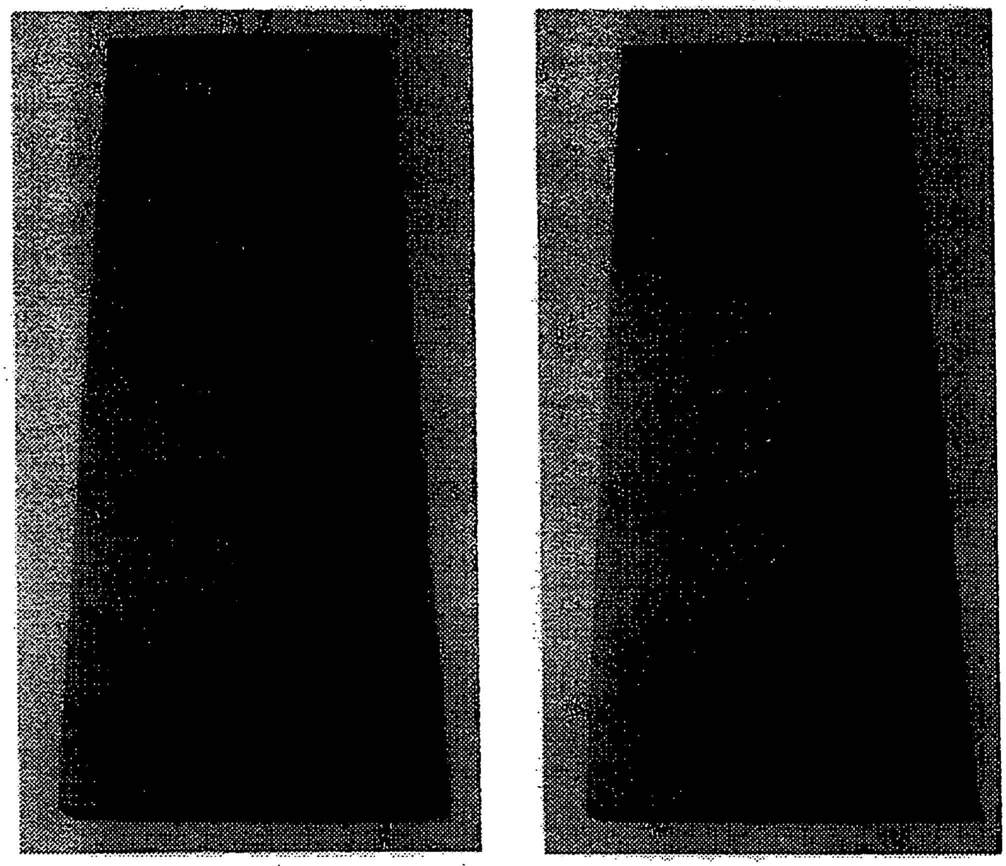


Figure 5



(a) (b)

Figure 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 98/00779

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B23K26/00 B23K33/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	see the whole document ---	9,10
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X	US 5 626 776 A (MORRIS JR H EDWARD) 6 May 1997	1,4,7,8
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[X] Further documents are listed in the continuation of box C.

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X	PATENT ABSTRACTS OF JAPAN vol. 010, no. 130 (M-478), 14 May 1986 & JP 60 255294 A (KUBOTA TEKKO KK;OTHERS: 01), 16 December 1985	1,7,8
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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Information on patent family members

International Application No
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